THE
Malayan Agricultural Journal.

Vol. XVII. OCTOBER. No. 10.

Preliminary Note on Variation of Individual Fruits of the Oil-Palm Grown Under Avenue Conditions.

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The last few years have shown that the Oil-palm can be grown as a profitable plantation crop in Malaya and that the extension of this new industry is assured, consequently an active interest is taken in this important crop by the Department of Agriculture.

As is well known, variation exists in all crops and plants and the present notes form a record of a preliminary study of variation in several characters of the fruits of the oil-palm which may prove useful in the selection of good parent palms as seed suppliers for future plantations.

The characters briefly surveyed in these notes embrace (i) weight of fruits, (ii) volume of fruits, (iii) weight of pericarp per fruits, (iv) volume of pericarp per fruits, (v) weight of nuts, (vi) volume of nuts, (vii) weight of kernel, (viii) weight of shell.

All the fruits from which these data were collected were obtained from successive palms planted in 1922 in two adjacent rows on the Government Experimental Plantation at Serdang.

Fruits were supplied from individual palms in sample lots of 25 by the Agricultural Division of the Department of

Agriculture and most of the samples from each palm were repeated two, three or more times, the repetitions being usually at intervals of several months.

The palms in one row (odd numbers) were artificially pollinated and those in the other row (even numbers) were not artificially pollinated.

The data collected from artificially pollinated palms are shown in Table I and can be compared with those collected from palms which were not artificially pollinated and which are compiled into Table II.

The figures in these Tables are taken from the records kept during the past two years but are given here to the nearest 5. The standard deviation is also calculated to the nearest 5 except for column 7 in which the nearest whole number is given. The co-efficient of variability is stated to the nearest 5%. Table III shows how the calculations were made. The remaining Tables are omitted to save space.

While most of the figures are derived from three sample lots (or seventy five fruits) further measurements from three or four more samples from each palm would have been desirable in order to embrace variations due to seasonal causes or increased maturation (since the palms are not yet in full bearing) and to render the figures more accurate.

The present figures, however, form a useful indication of the variations in the population of palms under observation though the trees are not yet sufficiently mature to enable correlations between the various characters of the fruit and the yielding ability of the palms to be made. A similar but incomplete study on fruits from 600 palms on a local commercial estate has shown that the variations indicated in these notes very closely resemble those found on palms growing under strictly commercial conditions.

The above tables (I and II) from both naturally and artifilially pollinated palms disclose average relationships for the parts of individual fruits which closely approximate the higher figures given by the Chemical Division in the Malayan Agricultural Journal, Vol. XV. 1927, page 349. It might be noted that the several parts of the fruits are in the same proportions for both means of pollination.

TABLE I.

Artificially Pollinated Palms.

1	2	3	4	5	6	7	8	9
Palm No. at Serdang.	Average weight per 25 fruits in grms.	Average volume per 25 fruits in c. cs.	Average weight of peri-carp per 25 fruits.	Average volume of pericarp per 25 fruits.	Average weight of nuts per 25 fruits.	Average weight of kernel per 25 nuts.	Average weight of shell per 25 nuts.	Average volume of 25 nuts.
1	490	450	285	275	205	38	165	175
3	550	500	350	340	200	38	160	160
5	520	460	330	315	190	35	155	145
7	635	580	395	400	240	51	190	180
9	435	405	260	265	175	35	140	140
11	405	355	255	240	150	24	125	115
13	410	405	235	260	175	35	140	145
15	195	185	110	120	85	16	70	65
17	470	415	275	265	195	28	170	150
19	515	470	315	315	200	33	170	155
21	555	490	345	330	210	37	170	160
23	450	410	250	245	200	42	160	165
25	470	435	290	285	180	48	135	150
27	480	430	290	285	190	36	155	145
29	175	160	95	95	80	16	65	65
31	365	345	235	240	130	30	100	105
33	450	410	270	270	180	29	150	140
35	510	440	335	305	175	23	150	135
37	475	440	275	285	200	33	165	155
39	445	400	250	250	195	33	165	150
43	455	415	285	285	170	31	140	130

1	2	3	4	5	6	7	8	9
Palm No. at Serdang.	Average weight per 25 fruits in grams.	Average volume per 25 fruits in c. cs.	Average weight of pericarp per 25 fruits.	Average volume of pericarp per 25 fruits.	Average weight of nuts per 25 fruits.	Average weight of kernel per 25 nuts.	Average weight of shell per 25 nuts.	Average volume of 25 nuts.
47	510	465	315	305	195	38	160	160
49	460	425	280	285	180	21	155	140
51	440	385	290	265	153	19	130	120
53	400	365	260	240	140	38	105	125
55	465	425	265	270	200	30	170	155
57	535	475	345	330	190	36	155	145
59	520	490	330	340	190	23	170	150
61	410	380	215	220	195	55	140	160
63	345	300	205	190	140	34	105	110
65	540	505	330	335	210	41	170	170
67	555	485	370	335	185	34	150	150
69	320	305	185	200	135	38	95	105
71	500	470	310	315	190	32	155	155
73	365	330	215	220	150	30	120	110
75	325	325	155	175	170	39	130	150
77	365	340	225	230	140	26	115	110
79	300	280	165	170	135	33	100	110
81	385	340	200	195	185	36	150	145
83	580	510	285	275	295	65	230	235
85	450	410	230	240	220	42	175	170
Totals 41 palms	18225	16610	10905	10805	7320	1401	5920	5805
Means	445	405	265	265	180	34	145	140
Standard Deviation	100	85	65	60	40	10	30	30
Co-efficient of variability	22.5	21	24.5	22.5	21	28.5	21.5	21.5

TABLE II.

Naturally Pollinated Palms.

1	2	3	4	5	6	7	8	9
Palm No. at Serdang.	Average weight of 25 fruits in grams.	Average volume of 25 fruits in c. cs.	Average weight of pericarp per 25 fruits.	Average volume of pericarp per 25 fruits.	Average weight of 25 nuts.	Average weight of kernels per 25 nuts.	Average weight of shell per 25 nuts.	Average volume of 25 nuts.
2	975	850	640	615	335	60	275	265
4	745	675	450	440	295	50	245	235
6	415	375	210	205	205	32	170	170
10	680	580	425	375	255	46	210	205
12	410	390	220	225	190	48	140	165
14	590	550	380	385	210	51	160	165
22	525	490	300	310	225	37	185	180
26	575	540	390	395	185	28	155	145
28	595	550	385	385	210	36	175	165
32	375	360	215	200	160	41	120	160
38	520	460	340	315	180	39	140	145
40	465	445	300	320	165	43	125	125
44	550	515	340	345	210	46	165	170
46	605	560	400	400	205	23	180	160
48	680	650	435	465	245	28	215	185
54	730	650	475	445	255	42	215	205
56	600	550	355	350	245	44	200	200
60	630	575	365	365	265	37	225	210
64	815	745	500	490	315	56	260	255
66	700	640	400	395	300	53	250	245
68	510	480	335	340	175	44	130	140

1	2	3	4	5	6	7	8	9
Palm No. at Serdang.	Average weight of 25 fruits in grams.	Average volume of 25 fruits in c. cs.	Average weight of pericarp per 25 fruits	Average volume of pericarp per 25 fruits.	Average weight of 25 nuts.	Average weight of kernels per 25 nuts.	Average weight of shell per 25 nuts.	Average volume of 25 nuts.
70	550	535	330	365	220	38	180	170
72	685	620	480	455	205	53	155	165
74	430	400	245	245	185	33	155	155
76	710	610	420	375	290	50	240	235
78	325	295	185	180	140	33	105	115
80	550	515	350	355	200	44	155	160
84	510	460	270	280	240	60	180	180
86	630	560	325	325	305	54	250	230
Totals 29 palms	17080	15655	10465	10345	6615	1250	5360	5310
Means	590	540	360	355	230	43	185	180
Standard Deviation	145	120	95	95	50	10	50	45
Co-efficient of variability.	24.5	22	26.5	26.5	21.5	22	27	25

I. Variation in Weight of Fruits.

(a) From artificially pollinated palms.

Column 2 of Table I shows the average weights per sample of 25 fruits from 41 palms planted in a row at the Government Plantations, Serdang.

These weights are grouped in Table III which shows that the Sandard Deviation is 100 grammes per sample of 25 fruits with a mean weight of 445 grammes and that, therefore, the Co-efficient of Variability is 22.5.

The Standard Deviation is the average deviation above and below the mean weight (or volume as the case may be),

and by addition and subtraction gives the figures around which variation occurs on each side of the mean. By calculating the standard deviation as a percentage of the mean, the Co-efficient of Variability is found. This co-efficient is a useful index of the amount of variation which may be found in any particular character for purposes of comparison with variations of the same or different characters in different or in the same palms.

(b) From naturally pollinated palms.

Fruits from 29 palms growing in the open pollinated row at Serdang were examined and the data gained thereby are tabulated in Table II, column 2 of which shows the average weights per sample of 25 fruits. In this case the standard deviation is 145 grammes for a mean weight per sample of 590 grammes, and the co-efficient of variability is therefore 24.5.

Thus, for the naturally pollinated palms the variability in weight of fruits is slightly greater than it is for adjacent palms which are pollinated artificially.

It may also be noted that the average weight per sample of fruits from naturally pollinated palms exceeds that for fruits from the artificially pollinated palms by over 32%.

With regard to this difference in the size of the fruits it is perhaps unnecesary to point out that in the single row of palms which were artificially pollinated many more female flowers were reached by the abundantly sprinkled pollen causing many more fruits to set in the bunches of these palms compared with those in which pollination was not aided. There was, therefore, less crowding and more available food supply for the development of the individual fruits on the palms which were naturally pollinated as compared with the individual fruits on the artificially pollinated palms, though the total weight of fruit per palm was much higher in favour of the latter.

It must be borne in mind that these are young palms which only commenced to bear fruit in 1926 and that they are planted in a single line, whereas, had the palms been planted in the usual estate formation, the natural means of pollination would have been greatly facilitated.

In young oil-palms, variation in the fruits of artificially pollinated palms may possibly be a more reliable guide to inherent characters that the variation in the fruits of palms pollinated naturally and unevenly by chance pollen.

TABLE III.

Variation in weight of Fruits from Artificially Pollinated Palms.

Group.	Frequency.	Mean.	Deviation.	(Deviation)^2	F × d^2
645	1	= 445	200	40000	40000
545	12		100	10000	120000
445	18		0	0	0
345	8		100	10000	80000
245	0		200	40000	0
145	2		300	90000	180000
	41				$\Sigma Fd^2 = 420000$

Standard Deviation = $\sqrt{\frac{\Sigma fd^2}{N}} = \sqrt{\frac{420000}{41}} = 100$

Co-efficient of Variability = $\frac{\text{S. D.} \times 100}{M} = \frac{10000}{445} = 22.5\%$.

(b) *Variation in weight of Fruits from Naturally Pollinated Palms.*

Group.	Frequency.	Mean	Deviation.	(Deviation)^2	F × d^2
990	1	= 590	400	160000	160000
890	0		300	90000	0
790	2		200	40000	80000
690	6		100	10000	60000
590	10		0	0	0
490	5		100	10000	50000
390	4		200	40000	160000
290	1		300	90000	90000
	29				$\Sigma Fd^2 = 600000$

Standard Deviation = $\sqrt{\frac{\Sigma fd^2}{N}} = \sqrt{\frac{600000}{29}} = 145.$

Co-efficient of Variability = $\frac{\text{S. D.} \times 100}{M} = \frac{14500}{590} = 24.5\%$.

The variations in the remaining characters are compiled into Table IV, which is self explanatory. The standard deviations and the co-efficients of variability having been determined similarly to those in Table III.

TABLE IV.

Summary of Variations.

(a) = Artificial pollination. (b) = Natural pollination.

Character.		Range.		Mean.	Standard Deviation.	Co-efficient of Variability
		Min.	Max.			
Weight of fruits	(a)	175	635 grms.	445 grms.	100 grms.	22.5
,, ,, ,,	(b)	325	975 ,,	590 ,,	145 ,,	24.5
Volume of fruits	(a)	160	580 c.cs.	405 c.cs.	85 c.cs.	21
,, ,, ,,	(b)	290	880 ,,	540 ,,	120 ,,	22
Weight of pericarp	(a)	90	400 grms.	265 grms.	65 grms.	24.5
,, ,, ,,	(b)	180	640 ,,	360 ,,	95 ,,	26.5
Volume of pericarp	(a)	95	400 c.cs.	265 c.cs.	60 c.cs.	22.5
,, ,, ,,	(b)	180	615 ,,	355 ,,	95 ,,	26.5
Weight of nuts	(a)	80	295 grms.	180 grms.	38 grms.	21.
,, ,, ,,	(b)	140	335 ,,	230 ,,	50 ,,	21.5
Volume of nuts	(a)	65	235 c.cs.	140 c.cs.	30 c.cs.	21.5
,, ,, ,,	(b)	140	265 ,,	180 ,,	45 ,,	25
Weight of kernel	(a)	16	65 grms.	34 grms.	10 grms.	28.5
,, ,, ,,	(b)	23	60 ,,	43 ,,	10 ,,	22
Weight of shell	(a)	65	230 grms.	145 grms.	30 grms.	21.5
,, ,, ,,	(b)	105	275 ,,	185 ,,	50 ,,	27

While the variations outlined in these notes merely form a preliminary survey of observations made on a comparatively small number of palms growing under avenue conditions, further observations which are in progress will, in the opinion of the writers, show little material divergence from the variations now shown. This opinion is based on the results of examinations (unpublished) of fruits from palms grown under strictly commercial conditions, and, therefore, no apology is tendered for publishing these preliminary notes on variation in the characters of individual fruits from palms planted in an avenue. In the meantime, data derived from the examination of fruits from a fair population of palms grown under commercial conditions, together with records of total fruit production per palm, are being compiled.

While the practice of pollinating young palms in order to expedite crop returns is likely to continue, estates already recognise the inadvisability of continuing it unduly for physiological reasons, and, possibly, they may be influenced also by its effects on costs of collection of fruits. Experience seems to indicate that palms cannot long maintain the heavy rate of production of fruit resulting from artificial pollination except where environmental conditions are particularly favourable, unless the palms are aided by the application of suitable manures. Thus, the question of policy as regards artificial pollination becomes essentially a problem of economics, which must be tackled on all producing areas.

Records of the total weight of fruits produced annually by each of the palms in the avenue to which the notes refer, are being maintained by the Assistant Agriculturist and published each year in the Malayan Agricultural Journal

Received for publication 11th June, 1929.

Variations in the Amount of Ether Extract of Tuba Root (*Derris Malaccensis*, Prain).

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Introductory.

An account was given in a previous number of this Journal, Vol. XII, 1929, No. 9, page 326 of an investigation regarding the variations in the amount of ether extract of tuba root, *Derris elliptica*, Benth., of different ages, reference also being made to a further series of experiments being carried out with the other variety of tuba root commonly cultivated, *D. malaccensis*, Prain.

It is to be noted that there are two forms of the latter species, differing in their habits of growth. One form is of an erect habit, while the other is low-growing. Both forms are under cultivation at the Government Plantation, Serdang.

The present paper summarises the results obtained with the erect form which was obtained originally from Sarawak and is frequently referred to as *Derris malaccensis* (Erect Sarawak).

In this instance the individual plots at Serdang were too small to allow of the figures being used as a basis for calculating the results likely to be obtained when cultivating on a large scale and the investigation was therefore confined to a determination of the amount of ether extract in the root at varying ages.

It may be mentioned here that as a result of the increased ether extract content of the roots of this form of *D. malaccensis* larger plots have now been laid down at Serdang on which it is intended to carry out a similar investigation to that already described for *D. elliptica*.

Method of Analysis.

The harvesting of the roots, the selection of "coarse" and "fine" roots, the preparation of the sample for analysis and the determinations of moisture and ether extract were carried out in a similar manner to that described previously for *D. elliptica*.

TABLE I.

Moisture Content and Ether Extract Content of Fine and Coarse Roots of Tuba Root (*Derris malaccensis*) of Varying Ages.

Time of harvesting.	Age of roots. months.	Moisture content. per cent.	Ether extract. per cent.	Ether extract (on moisture-free basis) per cent.
A. Fine Roots.				
December 1928 ...	19	6.74	28.46	30.52
February 1929 ...	21	10.24	29.74	33.13
April 1929 ...	23	11.04	30 39	34.16
June 1929 ...	25	9.48	25.07	27.70
August 1929 ...	27	7.48	19.91	21.52
B. Course Roots.				
December 1928 ...	19	8.71	27.00	29.58
February 1929 ...	21	11.82	28.15	31.92
April 1929 ..	23	11.48	28.52	32.22
June 1929 ...	25	5.46	24.84	26.34
August 1929 ...	27	9.72	19.21	21.28

The analytical results for the various samples are shown in Table I.

Remarks and Conclusions.

The results of analysis show that the amounts of ether extract for both "fine" and "coarse" roots of this form of *D. malaccensis* are much greater than those for *D. elliptica* of similar age. For example, in the case of the "fine" roots the amount is on the average four times as great, while for the "coarse" roots 25 months old there is an increase of as much as eight times in the amount of the ether extract, calculated on a moisture-free basis.

The figures also show that similar to *D. elliptica* the maximum amount of ether extract for "fine" roots is obtained after 23 months, roots of greater age showing a definite decrease in this respect. The maximum figure for the "coarse" roots is also obtained at the same age.

Assuming that the amount of ether extract is a measure of the toxicity of the root the great difference in the figures for the two species points to the advisability of the establishment of standards for the valuation of tuba root based on the figure for the amount of ether extract. A premium should be paid for roots having a higher ether extract than the standard and a corresponding deduction made for those giving a figure below the standard.

It will be interesting therefore in due course to compare the yields of root obtained at varying ages since the results point to the probability of a greatly increased return per acre, provided the increased toxicity of the roots of this form of *D. Malaccensis* is recognised.

Summary.

1. The article deals with the question of the variation in the amounts of ether extract for roots of *Derris malaccensis*, (Erect Sarawak) harvested at different ages.

2. The results of analysis show that the amount of ether extract is greatly in excess of that obtained with *D. elliptica*, also that the optimum age for harvesting, as far as the above figure is concerned, appears to be when the plants are 23 months old.

Received for publication 16th September, 1929.

Pulasan and Rambutan Fats.

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Introductory.

An account was given in a previous number of this Journal, Vol. X, 1932, No. 9, page 332 of an investigation regarding the analytical constants of some local oils and fats of minor importance. Among these were pulasan and rambutan fats, which are obtained from the seeds of these well-known fruits.

Both fruits belong to the genus *Nephelium*, Natural Order Sapindaceæ, the pulasan fruit being known botanically as *N. mutabile*, while the rambutan is *N. lappaceum*.

The results of the investigation showed that, while the analytical constants of the fats were in close agreement, the fat content of the pulasan seed was approximately double that of the rambutan seed the figures, calculated on a moisture-free basis, being 64.0 per cent. and 37.9 per cent. respectively.

In view therefore of this wide variation in fat content and of the fact that enquiries were received recently regarding the possibilities of the commercial utilisation of the fats it was considered advisable to repeat the analyses with fresh fruits obtained locally.

Both pulasan and rambutan fats are interesting from a chemical standpoint in view of both the high solidifying points of the fatty acids and the high figures for their mean molecular weights. The latter indicate the presence of glycerides of fatty acids not usually present in vegetable oils and fats.

Fat Content of Seeds.

The seeds were extracted from the fresh ripe fruits, washed from adhering pulp and dried in the sun for one day.

Both seeds are similar in appearance, being obovate in shape, and pointed at one end. Pulasan seeds are somewhat larger than rambutan, the former being approximately $1\frac{1}{4}$ inches long, $\frac{1}{2}$—$\frac{5}{8}$ inch broad and $\frac{1}{4}$—$\frac{3}{8}$ inch thick, while the latter are approximately 1 inch long, $\frac{3}{8}$ inch broad and $\frac{1}{4}$ inch thick.

A thin whitish skin covers the kernel in both cases, the flesh of the kernel being yellowish-white in colour.

The results of analysis of duplicate samples are shown in the following table :—

Seed.	Pulasan seed	Rambutan seed
	grammes.	grammes.
Average weight of seed	2.5	1.4
	per cent.	per cent.
Proportion of skin	8.5	5.6
Proportion of kernel	91.5	94.4
	100.0	100.0
Kernel.		
Moisture (loss at 100°C)	16.3	16.9
Oil (petroleum ether extract)	62.7	29.9
Residue (by difference)	21.0	53.2
	100.0	100.0
Oil (calculated on moisture-free basis)	74.9	36.0
Nitrogen (on moisture-free & fat-free residue)	5.4	1.8

Analytical Constants of Oil.

The kernels were shredded and dried, passed between rollers and pressed hot in the small laboratory hand-press.

Both fats are white solids at the ordinary temperature, melting at approximately 38°C to pale yellow oils. In each case the fat has a faintly sweetish smell.

The average results of duplicate determinations of the more important analytical constants are shown in the following table :—

	Pulasan fat.	Rambutan fat.
Fat.		
Specific gravity at 99°C (water at 15.5°C = 1)	0.8588	0.8595
Refractive index at 40°C	1.4570	1.4587
Saponification value	194.5	194.9
Iodine value (Wijs)	35.2	42.2
Unsaponifiable (per cent.)	0.3	0.5
Acid value	0.2	0.6
Fatty Acids.		
Solidifying point (Titer value)	52.8°C	56.9°C
Mean molecular weight	285.3	291.6
Neutralisation value	196.6	192.4
Iodine value (Wijs)	37.2	44.9

Remarks and Conclusions.

As regards the fat contents of the two seeds the figures confirm the results obtained previously.

The figures for the physical and chemical characteristics of the fats agree favourably with those obtained previously and published by other investigators.

Since the seeds are only available for a short period during the year and the trees are more highly esteemed for their fruit it is unlikely that either of these fats will ever be of economic importance.

Either pulasan or rambutan fat could, however, be used for edible purposes, while the high solidifying points of the fatty acids would render them both suitable in the manufacture of hard soap.

Received for publication September 4th, 1929.

A New Method of Drying Oil Palm Nuts.

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Introductory.

Experiments have shown that in order to crack oil palm nuts satisfactorily in a nut cracker of the centrifugal type the moisture content of the kernels should not exceed 12-14 per cent. If the kernels have a higher moisture content the result will be an increase in the percentage of both broken kernels and uncracked nuts owing to the reduction in the moisture content of the kernel having been insufficient to allow of the necessary shrinkage in the nut.

Our investigations have also shown that the moisture contents of both shells and kernels from freshly screened nuts from the centrifugal extractor are of the same order as in nuts from fresh fruits, the moisture content of the shells varying from 11 to 13 per cent. that of the kernels from 25 to 28 per cent. It is only occasionally that the figure for the moisture content of the kernels in nuts from the centrifugal extractor residue is less than the minimum figure quoted above.

The above figures show therefore that in order to effect satisfactory cracking the moisture content of the kernel must be reduced by approximately 50 per cent. Further, it will be realised that, since all this moisture must be transmitted through the shell, the problem resolves itself into a question of efficient and economic drying.

Methods of Drying.

On large oil palm estates flue gases from the boilers or sometimes from special furnaces are employed to heat continuous rotary dryers for treatment of the nuts. The temperature of such a dryer is graduated from approximately 200°C to 120°C, the moist nuts being fed into the hotter end of the dryer so that they are brought as rapidly as possible to a temperature at which they will commence to lose mois-

ture. The nuts cannot, however, be exposed to such an elevated temperature for any length of time without affecting the colour of the kernels, experiments having shown that by maintaining nuts at a temperature of 150°C for about 25 minutes a proportion of the kernels turns brown.

Such a method although giving satisfactory results is too elaborate and costly for use on small estates on which the usual practice is to dry the nuts for about 4 hours on an open kiln erected under a covered shed. The moist nuts are spread in a thin layer on iron sheets beneath which a fire is lighted, the nuts being turned over periodically in order to prevent the kernels from becoming overheated and developing a brown colour.

The drying of nuts by this method is not particularly satisfactory since too much depends on the skill of the cooly in maintaining even firing, and the proportions of broken kernels and unbroken nuts observed in some cases in the mixture coming from the nut cracker show that the method is not altogether efficient.

The method of sun-drying, which has been adopted on some estates, is also not entirely satisfactory owing to the uncertainty of the weather. While good results are obtained during a dry spell, when the nuts can be dried in 3-4 days, the accumulation of nuts during a wet spell causes delay in the recovery of the kernels.

New Method of Drying.

A new and simple method of reducing the moisture content of the kernels has recently been brought to the notice of the writer by Mr. J. Nicoll, Manager of Hopeful Estate, Batang Berjuntai. This method, which has been in use on his estate for the past three or four months, has given satisfactory results and, since a considerable saving in both fuel and labour is effected, the method has much to recommend it for general use on oil palm estates.

The method consists in stacking the moist clean nuts from the depulping screen for 10 to 12 days under a covered shed. During this period the pile of nuts becomes hot and a considerable amount of moisture is evolved which results in a reduction in the moisture content of the kernels. If a pile of nuts is examined after this period it will be noticed that

the nuts from the bottom of the pile to within 4-6 inches of the surface are dry and in many cases the kernels can be heard rattling in the shells when the nuts are shaken. The nuts to a depth of 6 inches from the surface are, however, still moist and must therefore be mixed with other nuts in the formation of a fresh pile. In this connection it is therefore suggested that it might be an advantage to stack the nuts in a space closed entirely except for ventilation holes for the escape of the moisture.

It is important to note that the period of drying indicated above should not be exceeded. In some experiments in which nuts have been stored for longer periods a large proportion of kernels has been found to be discoloured.

The nuts dried as described above crack easily, the absence of both unbroken nuts and broken kernels being particularly noticeable.

Results of Analysis.

The following table gives the results of analysis of two samples of nuts taken on different visits to the estate:—

Serial No. of sample.	Nuts from depulping screen.		Nuts from pile stacked for 10 days.	
	Moisture content of shells.	Moisture content of kernels.	Moisture content of shells.	Moisture content of kernels.
	per cent.	per cent.	per cent.	per cent.
Sample 1	13.1	27.2	12.5	13.1
Sample 2	13.2	26.6	11.5	10.5

The results show therefore that the reduction in moisture content is more than sufficient to enable the nuts to be cracked satisfactorily in a nut cracker of the centrifugal type.

In this connection it is also interesting to note that while the moisture content of the kernels shows such a considerable reduction the loss of moisture in the shell is negligible.

In order to ascertain whether any loss of oil occurred during the process, two samples of kernels were analysed. The results, which are shown in the following table, show that the figures are normal and that there is no excessive exudation of oil during the period of drying.

	Sample A per cent.	Sample B per cent.
Moisture (loss at 100°C)	11.8	11.4
Oil (petroleum ether extract)	45.4	46.6
Residue (by difference)	42.8	42.0
	100.0	100.0
Oil (calculated on moisture-free basis)	51.5	52.6

A small loss of kernel oil occurs, however, during the process of drying since if fragments of the broken shells are extracted with solvent the recovered oil contains traces of palm kernel oil as judged by the figure for the iodine value of the mixed oil. The loss of kernel oil is not serious, since it is only approximately equivalent to the amount of palm oil remaining on the surface of the nuts. Further, judging by the colour of the extracted oil, it is possible that some of the oil, calculated as palm kernel oil, may be in reality traces of organic matter from the shell extracted by the solvent.

Although during the process of drying there is a considerable evolution of moisture no marked increase takes place in the acidity of the kernel oil. For example, on one occasion samples of the nuts were taken from both the bottom and centre of a pile and the acidities of the two samples of oil expressed in the small laboratory hand-press were found to be 0.12 and 0.19 per cent. of lauric acid respectively.

Samples of the kernels have also been examined for discolouration, particular care being taken to note any kernels showing the slightest signs in this respect. In the case of one consignment 9 per cent. were found to be discoloured, in the case of another sample only 8 per cent. In view of the fact that in nearly all samples of kernels a small proportion is frequently found to be off-colour it is not thought that this relatively small increase is sufficient to affect the quality to any extent.

Remarks and Conclusions.

The results of the investigation indicate that the new method of drying affords a satisfactory and inexpensive means of drying oil palm nuts for cracking.

No expense as regards the provision of a kiln or a dryer is involved and, even though a small proportion of the kernels may be slightly off-colour, it is considered that the saving in both capital and upkeep charges will more than compensate for any small reduction in price that the buyers may offer on account of the kernels possibly falling below the somewhat vague description of fair merchantable quality.

In conclusion the writer wishes to thank both the Manager of Hopeful Estate for supplying the necessary samples and Mr. Gunn Lay Teik for carrying out the analytical work in connection with the investigation.

Received for publication September 13th, 1929.

The Periodic Harvesting of Sisal Hemp.

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Introductory.

An account was given in a previous number of this Journal, Vol. XII, 1924, No. 11, page 352 of the possibilities of the development of a sisal hemp industry in Malaya.

It was shown that the plant (*Agave sisalana*, Perrine) was well suited to the conditions prevailing in the country, also that there was little difficulty in preparing a good quality fibre which would find a ready market, especially in view of the increasing demand for sisal fibre in the manufacture of binder twine used for the mechanical reaping of cereal crops.

Reference was also made in the paper to various experiments that were being conducted with this crop at the Government Plantation, Serdang. At the present time there are two 10-acre blocks on which cultivation experiments are being carried out, among the more important investigations being:—

(i) A comparison between bulbils and suckers as planting material.

(ii) The determination of the most suitable planting arrangement.

(iii) The optimum period for harvesting the leaves.

(iv) The preparation of fibre for valuation and sale on the London market.

The present paper concerns the third investigation and records the results of two years experiments as regards the variations in both the yield and tensile strength of fibre by harvesting the leaves at different intervals.

Planting.

A portion of one of the 10-acre blocks referred to above, Plot D, Block 23, was used for the purpose of this experiment. The area is situated on flat land, the soil consisting of a clay loam overlying a sandy sub-soil.

The area was planted during the latter part of 1924 with suckers obtained from mature plants. The suckers were planted in rows 8 feet apart and spaced 5 feet apart in the individual rows. This arrangement gives 1089 plants per acre.

It may be mentioned here that this is only one of several planting arrangements with which trials have been made at Serdang. In this connection the results to-date show that the most satisfactory method is undoubtedly a double row system, in which the plants are spaced alternately in close rows with a wide working space between each double row. Such an arrangement ensures not only a greater number of plants per acre compared with square planting but also provides increased facilities for cultivation and harvesting. For example, square planting 10 feet x 5 feet gives 871 plants per acre, but with the close rows 5 feet apart, the plants 5 feet apart in these rows and allowing 10 feet between each double row 1160 plants per acre can be obtained, an increase of approximately 33 per cent.

During the whole period of growth the land has been kept clean-weeded, no manure or lime having been applied.

Description of Experiment.

The portion of the block selected consisted of 17 rows of 39 plants. This area was divided into 9 sub-plots, each consisting of 20 alternate plants in a row, the remaining 19 plants being excluded from the experiment. There was a guard row between each row of 39 plants, while additional guard rows were included both on the sides and the ends of the experimental area.

The 9 sub-plots were divided into 3 groups of 3 sub-plots, the groups being harvested at intervals of 2 months, 4 months and 6 months respectively.

An indication of the general arrangement of the experimental area is given in the diagram on page 375.

Harvesting of Leaves.

The experiment was commenced in June 1927 when the plants were approximately 2½ years old. As a preliminary all mature leaves were removed from the plants throughout the block so as to ensure all groups being in the same condition as regards harvesting at the commencement of the experiment.

The various groups were harvested at the intervals indicated above, while the leaves from the plants in the guard rows were harvested at approximately 5 months intervals, this period having been originally selected as the cropping period for the whole of the 10-acre block.

The method adopted in selecting leaves for harvesting was to remove all those growing at an angle of 45° or less from the surface of the ground, an angle frame being used in the case of doubtful leaves.

When harvesting a sharp knife was used so as remove the leaf with a clean cut, thereby preventing damage both to the fibre near the end of the leaf and the cuticle of the leaf above. Further, the leaves were always severed as close as possible to the stem in order to ensure a maximum fibre content.

After cutting the leaves were bundled and weighed, special attention being given to these operations since in the case of this experiment the leaves had to be transported to the Department of Agriculture, Kuala Lumpur for the extraction of the fibre.

Determinations of the average length and width of the leaves were made by measuring 10 per cent. of those harvested. The results, however, afforded no indication of a general increase in either the length or width of the leaf with an increase in age of the plant except that in the case of leaves from the plots harvested every 2 months there was a tendency for the length of leaf to diminish, doubtless as a result of the too frequent harvesting. This point will be referred to again later.

In general it may be said that in the case of the other two groups the average figure for the length was approximately 48 inches, that for the width being approximately 4 inches.

Diagram of Experimental Area with Sisal Hemp at Government Plantation, Serdang.

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. A . B . C . A . B . C . A . B . C .
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. A . B . C . A . B . C . A . B . C .
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. A . B . C . A . B . C . A . B . C .
. . . . . .
. A . B . C . A . B . C . A . B . C .
. . . . . .
. A . B . C . A . B . C . A . B . C .
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. A . B . C . A . B . C . A . B . C .
. . . . . .
. A . B . C . A . B . C . A . B . C .
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. A . B . C . A . B . C . A . B . C .
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. A . B . C . A . B . C . A . B . C .
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. A . B . C . A . B . C . A . B . C .
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. A . B . C . A . B . C . A . B . C .
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. A . B . C . A . B . C . A . B . C .
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. A . B . C . A . B . C . A . B . C .
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. A . B . C . A . B . C . A . B . C .
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. A . B . C . A . B . C . A . B . C .
. . . . . .
. A . B . C . A . B . C . A . B . C .
. . . . . .

A = Cut two months
B = Cut four months
C = Cut six months
. = Plants not included in experiment.

Preparation and Testing of Fibre.

The fresh leaves were crushed between a pair of smooth rollers and treated in a raspador machine. The crude fibre was washed by hand in order to remove all particles of vegetable tissue. Further, in order to recover as large a proportion as possible of fibre from the leaf the residue from the raspador was also hand-picked, the leaf fragments being subsequently teased out by hand in order to recover the fibre.

The fibre was dried in the sun, brushed and weighed.

The figures for the yields of fibre from the separate groups during the two years of the experiment are recorded in Table I, the calculated yields of fibre per acre, based on the figures obtained for the groups, being added for purposes of comparison.

For the determination of the tensile strength of the fibre, bundles of 20 strands were cut to a length of 1 metre, weighed and broken in a Schopper testing machine. The length of the fibre between the jaws of the machine was fixed at 20 centimetres, 3 determinations of the breaking load being obtained with each bundle.

Sixty bundles of fibre, twenty from each sub-plot, were tested on the occasion of each cutting.

The results are shown in Table II, although in order to make the latter as concise as possible only the minimum, maximum and average figures have been entered.

Remarks and Conclusions.

With regard to the actual leaves harvested it is interesting to note in all cases during the second year of the experiment the diminution both in the number of leaves and in the average weight of leaf. The decreases are particularly noticeable in the case of leaves from the plots harvested every two months and the figures confirm those obtained in respect of length.

TABLE I.

Yields of Fibre from Sisal Hemp Leaves at Government Plantation, Serdang.

Interval between harvesting. months.	Number of leaves harvested.	Weight of leaves. lbs.	Average weight of leaf. ozs.	Weight of fibre. lbs.	Yield of fibre. per cent.	Calculated yield of fibre per acre. lbs.	Estimated recovery of No. 1 fibre per acre. lbs.
First year, June 1927-June 1928, plants $2\frac{1}{2}$-$3\frac{1}{2}$ years old.							
2 months ...	2238	2199	15.7	81.9	3.7	1490	1270
4 months ...	2162	2355	17.4	85.5	3.6	1550	1320
6 months ...	2183	2405	17.6	88.4	3.7	1600	1360
Second year, June 1928-June 1929, plants $3\frac{1}{2}$-$4\frac{1}{2}$ years old.							
2 months ...	1852	1483	12.8	79.8	5.4	1450	1230
4 months ...	1952	1875	15.4	107.0	5.7	1940	1650
6 months ...	2099	2242	17.1	131.6	5.9	2390	2030

TABLE II.

Tensile Strengths of Sisal Hemp Fibre from Government Plantation, Serdang.

Interval between harvesting. months.	Weight in grammes of 20 strands of fibre.			Breaking strain per gramme metre.		
	Minimum.	Maximum.	Average.	Minimum.	Maximum.	Average.
First year, June 1927-June 1928, plants 2½-3½ years old.						
2 months ...	0.719	0.769	0.740	21,830	24,230	23,380
4 months ...	0.722	0.771	0.752	21,900	23,000	22,420
6 months ...	0.681	0.763	0.722	23,270	24,330	23,800
Second year, June 1928-June 1929, plants 3½-4½ years old.						
2 months ...	0.665	0.800	0.736	21,130	23,200	21,940
4 months ...	0.752	0.916	0.853	20,530	23,730	21,740
6 months ...	0.843	0.941	0.892	23,350	23,530	23,440

Note.—The figures for the breaking strain have been calculated by dividing the amount of the breaking load in grammes by the weight in grammes of 20 strands of fibre.

Further, while in the case of the groups harvested at intervals of 4 months and 6 months there are considerable increases in the weights of fibre during the second year of the experiment there is an actual diminution in weight in the case of the group harvested at intervals of 2 months. This would appear to indicate that such an interval is too short to allow of adequate leaf development.

The figures for the fibre contents show in all cases a considerable increase, amounting to approximately 50 per cent, during the second year of the experiment.

With regard to the figures for the calculated yields of fibre per acre it must remembered that these refer to practically theoretical yields which would not be obtained under ordinary working conditions. The records of the figures for the different harvests show that the proportion of brushed marketable fibre varied from 80-90 per cent. of the total fibre content of the leaves and the figures in the last column of Table I have therefore been drawn up on a recovery basis of 85 per cent.

The figures for the weight per unit length of fibre during the second year of the experiment indicate that while there is a considerable increase in the average figure in this respect for leaves harvested at 4 months and 6 months intervals, the average figure for fibre for leaves harvested at two months intervals remains the same, in fact the decrease in the minimum figure would appear to indicate that there is a tendency for the average figure to diminish.

Similarly, the figures for the tensile strength indicate during the second year of the experiment a considerable decrease for fibre from leaves harvested every two months, the figures for leaves harvested at four and six months intervals being approximately constant.

A general consideration of the results to-date shows therefore that the optimum period between harvesting is 6 months. In this connection it may be mentioned that as indicated previously this period approximates to the length of the harvesting period originally selected for the 10-acre block under experiment. Further, it is found that if the leaves are left for a longer period a proportion of them is apt to bend over and become damaged.

Summary.

1. The present paper records the results of certain experiments carried out during the past two years at Serdang with regard to the variations in both the yields and the tensile strengths of fibre from leaves harvested at different intervals.

2. The results to-date show that the optimum period between harvesting, judged by the figures both for yield and tensile strength, is approximately 6 months.

3. Under such conditions the estimated yields of marketable fibre during the two years of the experiment are 1360 lbs. per acre and 2030 lbs. per acre respectively.

In conclusion the writers would like to record their appreciation of the share of the work carried out as regards this investigation by Mr. R. O. Bishop, the former Ag. Agricultural Chemist, during the first year of the experiment.

Received for publication 18th September, 1929.